The Narragansett Electric Company

d/b/a National Grid (Rhode Island Reliability Project)

RIPUC Dkt. No. 4029

Testimony of

David M. Campilii, P.E.

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PREFILED TESTIMONY OF DAVID M. CAMPILII

INTRODUCTION

Q. Please state your name and business address.

A. My name is David M. Campilii. My business address is 25 Research Drive, Westborough, Massachusetts 01582.

Q. By whom are you employed and in what position?

A. I am employed as a Consulting Engineer by National Grid in the Network Asset Planning Department.

Q. What are your responsibilities as a Consulting Engineer in the Network Asset Planning Department?

A. I am responsible for the design, licensing, and construction of underground transmission and underground distribution facilities.

Q. Please describe your education, training and engineering background.

A. I have a Bachelor of Science degree in electrical engineering from Northeastern University, and I am a registered Professional Engineer in the State of Rhode Island. I am a member of the Institute of Electrical and Electronic Engineers (IEEE) Insulated Conductors Committee (ICC). I have been working on underground transmission and distribution projects for approximately 24 years.

Q. Have you testified before the Public Utilities Commission or Energy Facility Siting Board in previous cases?

A. Yes, I testified before the EFSB on the Manchester Street Repowering Project, the E-183 Project and the Southern Rhode Island Transmission Project. I have testified before the PUC on the E-183 Project and the Southern Rhode Island Transmission Project.

Q. Are you familiar with National Grid's Rhode Island Reliability Project (the "Project")?

A. Yes, I am. In addition to familiarity with the overall project, I oversaw development of the underground alternatives to the proposed construction of the 359 345 kilovolt (kV) line between West Farnum Substation and Kent County Substation.

Q. What is the scope of your testimony in this proceeding?

A. The purpose of my testimony is to describe the underground alternatives which were considered as part of this Project.

Q. Are you familiar with National Grid's Energy Facility Siting Board Application, including the Environmental Report ("ER") prepared by VHB for the Project?

A. Yes, I prepared the analysis of underground alternatives in the ER.

<u>UNDERGROUND ALTERNATIVES</u>

Q. Please describe the underground alternatives that you examined for the Rhode Island Reliability Project.

A. Figure 5-2 to the ER, entitled "Alternative Underground Routes, Rhode Island Reliability Project" is a map of the Project area that identifies underground alternatives to the Project. As discussed in Section 5.6 of the ER, two underground alternatives were investigated, and one of these alternatives was developed as a project alternative. The two alternatives were:

Existing Overhead ROW Route: Use of the existing overhead ROW for an underground transmission cable was evaluated. As detailed in Section 5.6.1.1 of the ER, there are significant disadvantages with using this corridor for underground transmission. The most significant issues include extensive wetlands, wetland buffer zones, water bodies along the ROW route, and route topography issues. While it is possible to span many of these features with the proposed overhead line construction, underground construction would require trenching or other construction techniques through these areas. Initial construction and future maintenance would be difficult, and would be expected to have greater long term and short term environmental impacts than the proposed Project.

The constructability and environmental issues associated with this corridor caused us to reject this alternative on a screening level.

Public Roadway Network: As the second alternative, an underground route utilizing the public roadway network was developed. There are existing roadways that could be used to connect between the West Farnum Substation and the Kent County Substation. One such route was developed, as shown on Figure 5-2 of the ER.

While there would be significant temporary issues during construction such as traffic maintenance, the roadway network appeared to be feasible, and did not have either the significant constructability or environmental issues associated with the existing overhead ROW corridor. The roadway network alternative was developed as the most suitable underground alternative to the Project.

Q. Please explain the underground technologies which you considered for this Project.

A. As detailed in Section 5.6.2 of the ER, we evaluated High Pressure Fluid Filled (HPFF) pipe type cables and Solid Dielectric cables for the underground alternative. HPFF cables consist of three laminated paper polypropylene (LPP) insulated cables installed in a steel pipe. The pipe is filled with a synthetic dielectric (insulating) fluid, which is pressurized to 200 psi. Pressurizing equipment, consisting of pumps, reservoirs, and controls are required at one or both ends of the cables.

Solid Dielectric cables are insulated with an extruded "solid" material. At 345 kV, the solid dielectric insulation is referred to as Cross-Linked Polyethylene (XLPE). This type of cable is typically installed in concrete encased conduits.

For the Project underground alternative, the cable technology selected was solid dielectric. Major reasons for this included

a) The ability to match the needed cable capacity with one solid dielectric circuit, as opposed to two pipe type cables.

b) Pipe type cables would require approximately 400,000 gallons of dielectric fluid, pressurized to 200 psi, with possible environmental issues.

c) Cost and complexity were greater for the two cable pipe type system than for the single cable solid dielectric system.

Q. Are there operational and maintenance issues related to underground transmission lines compared to overhead lines?

A. Yes, there are several.

(a) <u>Outage Duration</u>: One of the biggest operational issues associated with an underground transmission line is lengthy repair times. Repair times for underground 345 kV transmission lines are on the order of 2 weeks to a month or longer. By contrast, with an overhead transmission line, failures or outages are usually corrected within 24 to 48 hours, or are only momentary in nature.

(b) Line Ratings: It can be difficult to match the power rating of an overhead line with underground cables. In this case, a very large cable would be required to satisfy the power flow requirements of the Project. Future capacity upgrades are typically more difficult with underground lines than overhead lines. In the case of the Rhode Island Reliability Project, spare conduits would be installed for future upgradeability.

(c) Cable Charging: Cables are significantly more capacitive than overhead lines. This can lead to voltage control issues at light load, or can require installation of additional equipment to compensate for the line charging. Simulations of the transmission system indicate that it could not absorb the 300 MVAR of line charging from the proposed cable. Addition of a 300 MVAR shunt reactor at the West Farnum Substation would be necessary to offset the cable capacitance.

(d) Reclosing: Many faults on an overhead line are temporary in nature. It is often possible to "reclose" (re-energize) an overhead line, resulting in only a momentary outage. Faults on underground lines are almost never temporary in nature, so reclosing is typically not performed for underground lines.

(e) Load Sharing: Cables have different impedance characteristics than overhead lines. If a cable is put in parallel with an overhead line, as would be the case here, the cable will tend to "hog" the load, resulting in possible power flow control issues. This could trigger the need for additional transmission equipment to better balance line flows.

These operational issues collectively make it more difficult and costly to incorporate transmission cables into the grid.

Q. What is the estimated cost of the underground alternative and can you please explain the process you used to arrive at these costs?

A. Table 5-4 of the ER details overall project costs for the proposed Project, and for the project with an underground alternative for the proposed 359 line. In the case of the proposed Project, the overall project cost is approximately $245 million. If an underground alternative is used for the 359 line between West Farnum Substation and Kent County Substation, the overall project cost is estimated to be $415 million, an increase in cost of approximately $170 million over the proposed Project.

The underground transmission estimate involved several components. These included installation of 23.5 miles of underground 345 kV transmission cable from the West Farnum Substation to the Kent County Substation, and modifications at West Farnum Substation and Kent County Substation to accept the underground transmission cables. For transmission system capacity, the underground alternative included overhead transmission reconductoring of the S171 and T172 115 kV lines between Hartford Avenue Substation and the Johnston tap in Johnston, and overhead reconductoring of the G185N 115 kV overhead line between Kent County Substation and Drumrock Substation in Warwick. To allow for substation expansion and reconfiguration, the underground transmission alternative also included the overhead relocation of a portion of the B23 115 kV line in the vicinity of West Farnum substation, and the overhead relocation of a portion of the G185S and L190 115 kV lines in the vicinity of Kent County Substation.

Estimates for the various components were performed using a combination of historic project costs from similar projects, estimating quotations from manufacturers and installers, and visual and "literature search" assessment of route features. The costs presented are study grade estimates which are expected to have an accuracy of +/-25% and are based on a conceptual design of a project.

Q. What is the most practical underground alternative?

A. Any underground alternative is expected to have significant cost, operational, and schedule disadvantages compared to the proposed Project. At this point, we believe the most practical underground alternative would be one that would use the roadway network, and which would utilize a solid dielectric cable construction.

Q. You have discussed a number of disadvantages of underground transmission. When would National Grid consider installing underground transmission lines?

A. In general, National Grid proposes overhead transmission lines as the preferred technology for most additions to the transmission system. This is primarily for reasons of cost, and for the reliability and operational issues discussed in the ER and in this testimony. However, there are occasions when National Grid may propose or accept underground transmission as the technology for a particular project. The most common situation where the National Grid would propose underground transmission is where National Grid had no ROW and no practical means to obtain a ROW (either due to cost, timing, or other reasons). The E105 and F106 cables between Manchester Street Substation and Hartford Avenue Substation are an example of this, where it would have been impractical to create a 250 foot wide ROW corridor from downtown Providence to the I-295 - Route 6 area of Johnston.

Another situation where National Grid would consider underground transmission would be a situation where an overhead transmission line would affect the operation of an airport. In this case, a short "dip" in the overhead transmission line would be installed, with overhead to underground transition station at each end of the underground transmission line.

National Grid will also consider underground transmission lines at or near existing substations when it is determined that there is inadequate space around or within an existing substation for a proposed expansion. This type of installation will typically take the form of a short underground "getaway" with a transition to an overhead transmission line outside the substation.

In cases of long water body crossings, where it is impractical to span the water body from shore line towers, National Grid will consider submarine cables (a form of underground transmission line) for the water crossing.

Finally, under some circumstances, National Grid will consider installing an underground transmission line when a customer requests underground supply and pays for the cost of the underground line. National Grid would evaluate the effect on the larger transmission system from this type of request.

In each of these circumstances, National Grid evaluates the particular issues associated with underground transmission lines (line ratings, longer outage restoration times, different electrical characteristics from overhead lines, etc.) Addressing these issues often results in installing more than one underground transmission cable in situations where a single overhead transmission line would have been adequate. Compensating for underground transmission issues also typically involves installing more equipment at the terminal substations, and sometimes imposing operating restrictions on the system.

Q. Does this complete your testimony?

A. Yes, it does.